REMARKS

Claims 7, 12 and 16 have been canceled. Thus, claims 1, 2 and 8-11, 13-15 and 17-19 remain pending for further prosecution in the present application. Applicant submits arguments, a sworn Declaration of Yuichiro Shindo, and a cited prior art reference in a Supplemental Information Disclosure Statement for overcoming the rejections over the prior art of record. Accordingly, Applicant respectfully submits that the present application is in condition for allowance.

I. Claim Rejections - 35 USC §112

> *A. In the non-final Office Action dated October 13, 2009, claims 7, 8 and 12-19 are rejected under 35 USC §112, first paragraph, as failing to comply with the written description requirement.*

Claims 7, 12 and 16 have been canceled. Thus, the rejection based on these claims is now considered moot.

With respect to claims 8, 13 and 17, it is stated in the non-final Office Action that the specification does not provide support for a hafnium material having a residual resistance ratio of 120 to 200. In addition, it is stated that these claims contain "subject matter that was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor, at the time the application was filed, had possession of the claimed invention."

Applicant again respectfully disagrees with the §112, first paragraph, rejection of claims 8, 13 and 17 and respectfully requests reconsideration and removal of the rejection for the following reasons. Applicant respectfully submits that hafnium material having a residual resistance ratio of 120 to 200 is described in the specification of the present application, as filed,

in such a way as to reasonably convey to one skilled in the relevant art that the inventor, at the time the application was filed, clearly had possession of the claimed invention.

One of ordinary skill in the art is clearly taught by the specification of the present application, as filed, that one of the objectives of the present invention is to provide a hafnium material having a high residual resistance ratio. See: page 3, lines 1-4; page 4, lines 19-21; and page 5, line 33, to page 6, line 2, of the present application, as filed. These sections of the present application read, as follows:

> "In particular, materials having a **high residual resistance ratio** are being demanded, and, since a high purity hafnium material could not be obtained conventionally, it was not possible to sufficiently meet the demands as electronic component materials since the **residual resistance ratio** was low";
>
> "Moreover, it is possible to obtain a thin film having a **high residual resistance ratio** from the high purity hafnium material, which will be able to sufficiently meet the demands as an electronic component material"; and
>
> "Moreover, a material having a **high residual resistance ratio** can be obtained from the foregoing high purity hafnium material as described in the following Examples, and it is possible to sufficiently meet the demands as an electronic component material."

Thus, one of ordinary skill in the art is clearly taught the significance of a hafnium material having a high residual resistance ratio by the present application, as filed. The specification clearly conveys in a reasonably manner to one skilled in the relevant art that the inventor, at the time the application was filed, had possession of the claimed invention, a hafnium material having a high residual resistance ratio.

Further, specific examples of hafnium materials according to the present invention are disclosed on pages 6-8 of the present application, as filed, as Example Nos. 1 to 3. Page 9, lines 4-9, of the present application, as filed, refers to these Examples and states:

> "With respect to the foregoing Examples 1 to 3, results of measuring the **residual resistance ratio** are shown in Table 4. As a result, as shown in Table 4, the **residual resistance ratio** at the ingot stage in Examples 1, 2 and 3 is respectively 38, 22 and 45, but respectively **increased after deoxidation at 200, 120, and 190**. Like this, it is evident that **hafnium having a high residual resistance ratio** can be obtained from hafnium having ultra high purity."

Table 4, on page 9 of the present application, as filed, reveals that the "hafnium material" of Example No. 2 has a "Residual Resistance Ratio" after deoxidation of **120** and that the "hafnium material" of Example No. 1 has a "Residual Resistance Ratio" after deoxidation of **200**. From these examples of the present invention, it is reasonably conveyed to one of ordinary skill in the art that a hafnium material having a residual resistance ratio of 120 (Example No. 2) to 200 (Example No. 1) would possess the desired "high residual resistance ratio" referred to on page 3, lines 1-4; page 4, lines 19-21; page 5, line 33, to page 6, line 2; and page 9, lines 4-9, of the present application, as filed.

Thus, support for the limitation stated in claims 8, 13 and 17 is clearly found in the specification of the present application, as filed. See Table 4 on page 9. Further, there is simply no question that the subject matter of claims 8, 13 and 17 is described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor, at the time the application was filed, had possession of the claimed invention -- a hafnium material having a high residual resistance ratio as defined by the entries in Table 4 of page 9 of the present application, as filed.

Accordingly, it is respectfully submitted that the above referenced limitation in claims 8, 13 and 17 comply with the written description requirement of §112, first paragraph, and are described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor, at the time the application was filed, had possession of the claimed

invention. Applicant respectfully requests reconsideration and removal of the §112, first paragraph, rejection of claims 8, 13 and 17 for these reasons.

> *B. In the non-final Office Action dated October 13, 2009, claims 7 and 12 are rejected under 35 USC §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.*

Claims 7 and 12 have been cancelled. Thus, this rejection is now considered moot.

II. Claim Rejections - 35 USC §103(a)

> *A. In the non-final Office Action dated October 13, 2009, claims 1-2 and 7-19 are rejected under 35 USC §103(a) as being obvious over U.S. Patent Application Publication No. 2003/0062261 A1 of Shindo.*

Independent claims 1, 2 and 11 of the present application require a hafnium material having an oxygen content of 40wtppm or less and a zirconium content of 0.1wt% (1,000wtppm) or less. Dependent claims 9, 14 and 18 further limit oxygen content to 10wtppm or less, and dependent claims 8, 13 and 17 require the hafnium material to have a residual resistance ratio of 120 to 200 which can only be achieved when oxygen content is reduced to the claimed ranges.

By way of example, the hafnium material of Example Nos. 1-3 disclosed in the present application, as filed, at the "ingot" stage of the present invention had oxygen contents of 250wtppm, 400wtppm, and 100wtppm, respectively, and provided low residual resistance ratios of 38, 22 and 45, respectively. In contrast, after "Deoxidation" according to the present invention, Example Nos. 1-3 had oxygen contents of less than 10wtppm, 20wtppm, and less than 10wtppm, respectively, and provided high residual resistance ratios of 200, 120 and 190,

respectively. Thus, the effect of low oxygen content is clearly demonstrated by the Examples disclosed in the present application.

Still further, a sworn Declaration of Yuichiro Shindo (the inventor of the present application) is submitted herewith and provides additional examples with respect to oxygen content obtained by the present invention and oxygen content obtained according to the prior art '261 Shindo publication.

In the Sworn Declaration, Example No. 1A and Example No. 1B are provided relative to the present invention. These examples are identical to Example No. 1 of the present application, as filed, as described on page 6, line 12, to page 7, line 9, of the present application, as filed. In Example No. 1, the hafnium ingot was subjected to "deoxidation at 1200°C for 5 hours with molten salt of Ca and $CaCl_2$". In contrast, in Example No. 1A, the hafnium ingot was subjected to deoxidation at 1250°C for 5 hours with molten salt of Ca and $CaCl_2$, and in Example No. 1B, the hafnium ingot was subjected to deoxidation at 1150°C for 10 hours with molten salt of Ca and $CaCl_2$. The oxygen content after deoxidation of the hafnium materials of Example Nos. 1A and 1B were 30wtppm and 40wtppm, respectively.

In contrast, the hafnium sponge obtained according to Example No. 1 of the present application, was subjected to the identical treatment disclosed in the prior art '261 Shindo publication. For example, see Paragraph Nos. 0082-0087 and 00120-126 of the prior art '261 Shindo publication. The hafnium material of this example reported in the Sworn Declaration had an oxygen content of 250wtppm which does not meet the limitations stated in independent claims 1, 2 and 11 of the present application and cannot provide a residual resistance ratio of 120 to 200 as required by claims 8, 13 and 17.

In the non-final Office Action, patentability is denied because the '261 Shindo publication discloses a hafnium material having an oxygen content of 500ppm "or less" and a zirconium content of 0.5wt% (5,000wtppm) "or less". Here, the lower limits referred to as "or less" are not specifically disclosed.

With respect to Examples provided by the '261 Shindo publication, Example 2 on Paragraph Nos. 0082-0089 of the '261 Shindo publication discloses that the oxygen content is 120ppm and that the Zr content is 0.35wt% (3,500wtppm). Further, Example 2 (second embodiment) on Paragraph Nos. 0120-0131 of the '261 Shindo publication discloses that the Zr content is 0.24wt% (2,400wtppm) and fails to disclose an amount of oxygen content. Although this second embodiment of the '261 Shindo publication does not describe oxygen content, Applicant respectfully submits that it is a clear error to simply assume that oxygen content is 0 (zero) just because no description is provided.

Accordingly, Applicant respectfully submits that the lower limit of the oxygen and zirconium contents achievable by one of skill in the art following the teachings of the '261 Shindo publication is an oxygen content of 120ppm and a Zr content of 0.24wt% (2,400wtppm). Both of these values are outside the scope of the independent claims 1, 2 and 11 of the present application. Applicant also submits that one of ordinary skill in the art following the teachings of the '261 Shindo publication is provided with no common sense reason to reduce oxygen content and zirconium content below the above stated levels. Thus, one of ordinary skill in the art following the '261 Shindo publication could not provide a hafnium material having a residual resistance ratio required by dependent claims 8, 13 and 17 of the present application. It would not be an inherent property of the hafnium material disclosed by the '261 Shindo publication.

Further, the oxygen content of 40ppm or less and the Zr content of 0.1wt% (1,000wtppm) or less of the present invention is significantly less than that disclosed by the lower limits of the '261 Shindo publication. Upon comparing the oxygen content of the present invention with that of the '261 Shindo publication, the present invention is able to reduce the oxygen content disclosed by the '261 Shindo publication by more than 1/3 from 120ppm to less than 40wtppm. Whether the reduction of the impurity content is small should not be judged based on subjective standards. Since it becomes more difficult to reduce the impurity content if the content itself is low to begin with, to reduce the content of 120ppm achieved by the '261 Shindo publication to 40ppm of the present invention is not something that can be achieved easily or should be considered obvious to one of ordinary skill in the art.

In addition, upon comparing the Zr content of that required by the present invention with that disclosed by the '261 Shindo publication, the present invention is able to reduce the Zr content more than 1/2 from 0.24% (2,400wtppm) to 0.1wt% (1,000wtppm). As explained in arguments submitted in previously filed Responses, the '261 Shindo publication provides one of ordinary skill in the art with no recognition that the zirconium contained in the hafnium is an impurity that must be eliminated. Thus, the '261 Shindo publication provides no motive for reducing zirconium to less than 0.24wt% (2,400wtppm). Thus, the zirconium content of 0.1 wt% or less achieved by the present invention could not have been easily achieved based on the teachings of the '261 Shindo publication and it should not be considered obvious to one of ordinary skill in the art.

Still further, it should be kept in mind that one of ordinary skill in the art has been explicitly taught by the '261 Shindo publication and others that zirconium and gas components in hafnium are not considered important and can be tolerated. For example, the '261 Shindo patent

application publication teaches to one of ordinary skill in the art that a large quantity of zirconium is contained in hafnium, that the separation and refinement between the two is difficult, and that the presence of zirconium "may be ***disregarded*** since the purpose of use of the respective materials ***will not hinder*** overall purpose hereof." (See Paragraph No. 0061 of the '261 Shindo published application.) Also, Paragraph No. 0065 of the '261 Shindo published application teaches to one of ordinary skill in the art that it is "***extremely difficult to reduce Zr*** in high purity hafnium" and "the fact that Zr is mixed in high-purity hafnium ***will not aggravate*** the properties of semiconductors, and ***will not be a problem***."

The same conventional sentiment is true for gas components, such as oxygen. Hafnium is an element that has a strong bond with oxygen, and the reduction of oxygen from hafnium is extremely difficult. Oxygen exists in hafnium in large quantities, not in trace amounts. By way of example, Table 4 shown on Paragraph No. 0131 of the '261 Shindo published application excludes gas components, such as carbon, oxygen and nitrogen, because according to conventional thinking, gas components are believed harmless, even if in large quantities.

Electron beam melting is described in the '261 Shindo published application. Electron beam melting cannot reduce oxygen to levels required by the present application. The '261 Shindo published application merely requires oxygen content to be at a level of about 500wtppm. Oxygen content is not considered overly important by the '261 Shindo published application. One example of the '261 Shindo published application shows oxygen content of 120wtppm after electron beam furnace melting. See Paragraph Nos. 0089 and 0092 of the '261 Shindo published application. Another example does not even bother to list oxygen content for reasons discussed above. See Paragraph No. 0131 of the '261 Shindo published application.

Accordingly, Applicant respectfully submits that one of ordinary skill in the art following the teachings of the '261 Shindo published application is not taught how to reduce oxygen content below 120wtppm and is not provided any common sense reason or motivation for limiting oxygen content to the reduced levels required by the claims of the present application.

In addition, the requirement of oxygen content being 40ppm or less as required by the claims of the present application is **critical and provides an unexpected result** relative to the teachings provided to one of ordinary skill in the art by the '261 Shindo published application. For reasons discussed above, the range of oxygen content required by the claims of the present application is critical to provide a hafnium material with a high residual resistance ratio. In addition, this result is unexpected to one of ordinary skill in the art following the teachings of the '261 Shindo application publication which only requires oxygen content to be reduced to about a 500wtppm level. There is no disclosure of any benefit achieved beyond this level.

Also, Applicant respectfully submits that it is fundamentally and technically inappropriate to argue that a hafnium material containing oxygen in an amount of 40wtppm or less can be stably produced by following the teachings of the '261 Shindo application publication. The reduction of oxygen has its limits based on the method of its purification. The '261 Shindo application publication only discloses electron beam melting, and it is not possible to achieve the oxygen content required by the claims of the present application solely with electron beam melting.

Therefore, Applicant respectfully submits that independent claims 1, 2 and 11 of the present application are not obvious in view of the '261 Shindo published application and that the properties required by dependent claims 8, 13 and 17 are not inherent in the materials disclosed

by the '261 Shindo published application. Accordingly, Applicant respectfully requests reconsideration and removal of this rejection.

B. In the non-final Office Action of October 13, 2009, claims 1, 2, 7-10 and 16-19 are rejected under 35 USC §103(a) as being obvious over ASM Handbook Volume 2, pp. 1093-1097.

Applicant respectfully submits that the ASM Handbook Volume 2, pp. 1093-1097, does not provide any analytical data concerning the impurities contained in Hf. Accordingly, Applicant respectfully submits that the assertion in the Office Action to the effect that "the purity of hafnium disclosed in the ASM Handbook Volume 2 **overlaps** with the purity of the instant invention" is erroneous. In fact, a reference ("Ref. 5") referred to by the ASM Handbook Volume 2 provides actual data relative to hafnium, and the purity and oxygen content are well outside of the scope of the claims of the present application. A copy of this document is being submitted via an Information Disclosure Statement filed herewith.

The above rejection relies on the disclosure in the section of the ASM Handbook having the sub-heading "Chemical Vapor Deposition" which begins in column 2 and ends within column 3 of page 1094 of the cited reference. The first sentence of the second paragraph of this section and the fourth paragraph of this section specifically refer to "**Ref. 5**". For example, the first sentence of the second paragraph of this section and the fourth paragraph of this section read, as follows:

> "One of the more popular of the chemical vapor deposition processes is the **iodide process**, which has been used extensively to purify titanium zirconium and chromium **(Ref 5)**"; and
>
> Other metals that have been purified by chemical vapor deposition include **hafnium**, thorium, vanadium, niobium, tantalum, molybdenum, and many less commercially important metals **(Ref. 5)**."

Page 1097 identifies "Ref. 5" as "R.F. Rolsten, *Iodide Metals*, Wiley, 1961". Pages 74-77 of Rolsten is provided via the Information Disclosure Statement filed herewith. The last few lines on page 76 of Rolsten states:

> "Hafnium that was prepared in six deposition experiments ranged from 98.92 to 99.22% purity and contained 140 to 500 ppm oxygen".

Thus, the hafnium material disclosed by Rolsten is not of 4N (99.99%) purity as required by the claims of the present application and the oxygen content is not 40wtppm or less as required by the claims of the present application. Rolsten is specifically referred to and relied upon by the ASM handbook.

As argued in Applicant's previously filed response, the third paragraph of the "Chemical Vapor Deposition" section of the ASM handbook begins with the words "In this process" referring to the "iodide process". This opening phrase specifically refers to the "iodide process" used with respect to only titanium, zirconium and chromium. For example, the third paragraph refers to purities of 99.96% for titanium, 99.98% for zirconium, and 99.995% for chromium. The third paragraph concludes with the statements that:

> "**Chromium** has been purified to its highest state to date by this method. Only iron is carried over with **these metals** to a significant extent. Thus, if a low-iron starting metal is used, the condensed vapor will approach a purity level of 99.999%."

The "approach a purity level of 99.999%" statement of the reference refers specifically to chromium, not hafnium. In addition, the only metals that could possibly be included in "these metals" are titanium, zirconium and chromium which are the subject of this particular paragraph. This statement is not made with respect to hafnium, and it is simply an error to misread this statement otherwise.

In the last paragraph of this section of the ASM Handbook Volume 2, it is stated that "other metals" have been purified and that the "other metals" include hafnium. The "other metals" are clearly not included in the "these metals" recitation in the preceding (i.e. third) paragraph of the section. The reference to "these metals" is made before a reference to hafnium or the "other metals" is ever made.

Applicant respectfully submits that reading hafnium into the third paragraph of the "Chemical Vapor Deposition" section of the ASM Handbook reference is incorrect and an error. The statements in the third paragraph apply to chromium and perhaps to titanium and zirconium. The statements clearly cannot be applied to hafnium or "other metals".

Applicant respectfully submits the ASM Handbook merely discloses that hafnium is among a group of "other metals" that can be purified to some undisclosed level by a chemical vapor deposition method. (See the final paragraph of the section titled "Chemical Vapor Deposition" on page 1094.) The ASM Handbook clearly fails to specifically disclose the zirconium content and oxygen content of a purified hafnium metal. Rather, the ASM Handbook cites "Ref. 5", Rolsten. Rolsten clearly provides a hafnium material of less than 4N purity and having 140 to 500wtppm of oxygen content.

Accordingly, Applicant respectfully submits that the ASM Handbook fails to describe in any way the zirconium content and oxygen content in purified hafnium. Rolsten, which is cited by the ASM Handbook, discloses a hafnium material that does not have 4N purity and that includes 140 to 500wtppm of oxygen content.

Therefore, Applicant respectfully submits that claims 1, 2, 8-10 and 17-19 of the present application are not obvious in view of the ASM Handbook and/or Rolsten. Applicant respectfully requests reconsideration and removal of the rejection.

III. Conclusion

In view of the above amendments, remarks, Sworn Declaration, and prior art Rolsten publication, Applicant respectfully submits that the claim rejections have been overcome and that the present application is in condition for allowance. Thus, a favorable action on the merits is therefore requested.

Please charge any deficiency or credit any overpayment for entering this Amendment to our deposit account no. 08-3040.

Respectfully submitted,
Howson & Howson LLP
Attorneys for Applicants

By /William Bak/
William Bak
Reg. No. 37,277
501 Office Center Drive
Suite 210
Fort Washington, PA 19034
(215) 540-9216